

Human-Robot Interaction: Language Acquisition with Neural Network

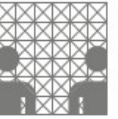
Alvin Rindra Fazrie



Universität Hamburg
Fakultät für Mathematik, Informatik und Naturwissenschaften
Fachbereich Informatik

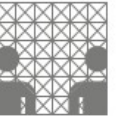
Technische Aspekte Multimodaler Systeme

09.11.2015



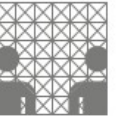
Outline

- Motivation
- Basics and Definitions
 - Natural Language Processing
 - Neural Network
- Neural Network Architecture
 - Single Layer Feed Forward Networks
 - Multi-Layer Feed Forward Networks
 - Recurrent Neural Networks
 - Echo State Network
- Stochastic Learning Grammar
- Conclusion



Motivation

Understanding and generating humans' natural language, it might be feasible in the future to address computers like humans.

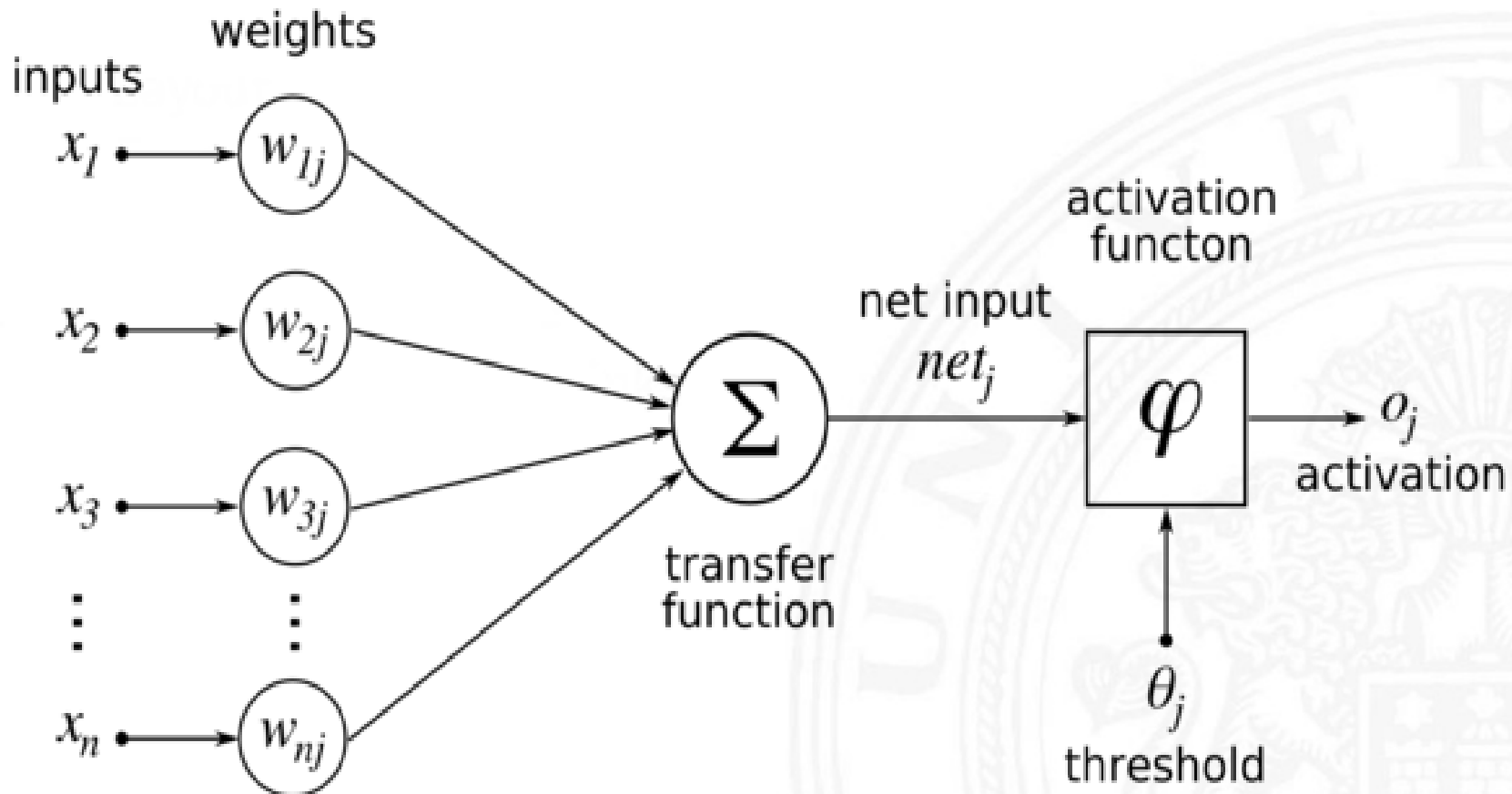


Natural Language Processing

- To analyze, understand and generate languages, that are used by humans.
- The structure of words (syntactic)
 - Part Of Speech tagging (POS)
 - Chunking
 - Syntactic Parser (PSG)
- Semantic Information
 - Named Entity Recognition (NER)
 - Semantic Role Labeling (SRL)
 - Word-sense Disambiguation

Neural Network

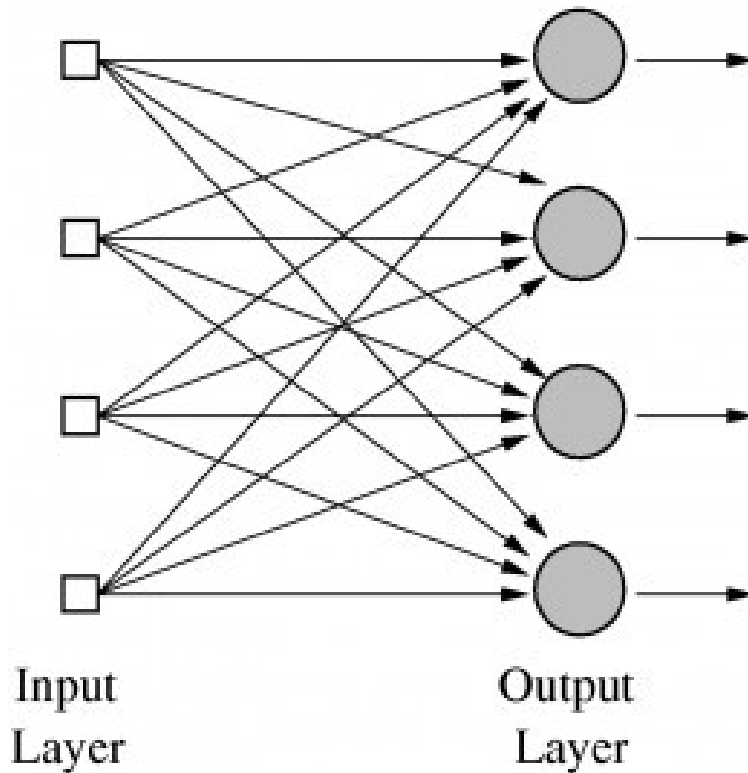
- Biologically inspired statistical learning algorithms



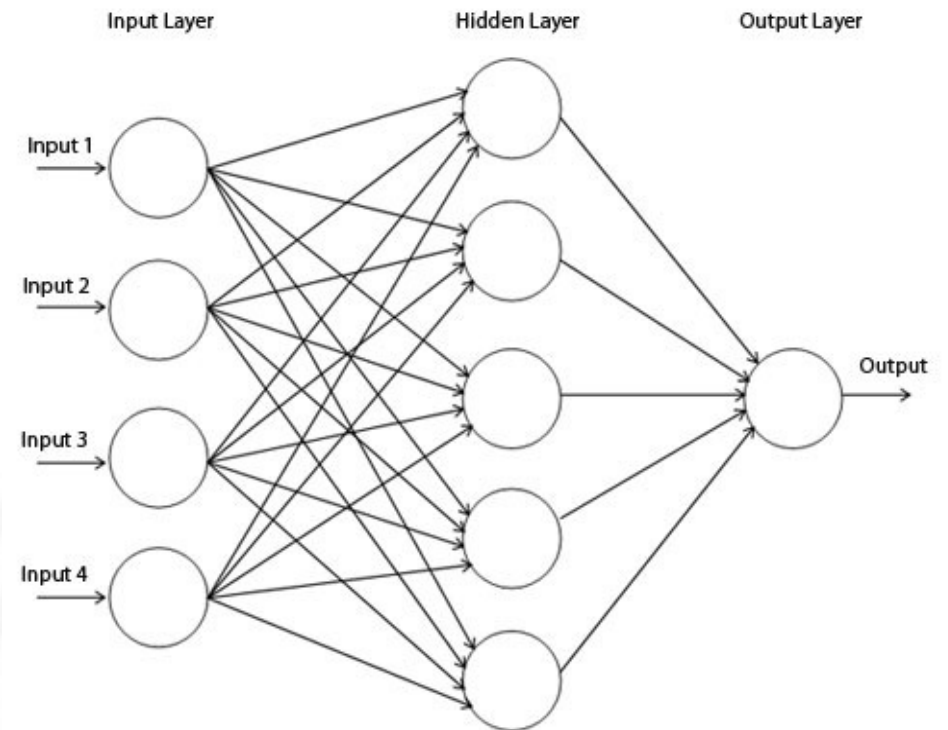
Picture 1. based on [HAY94]

Architecture

Single-Layer FeedForward Networks[1]



Multi-Layer FeedForward Networks[2]

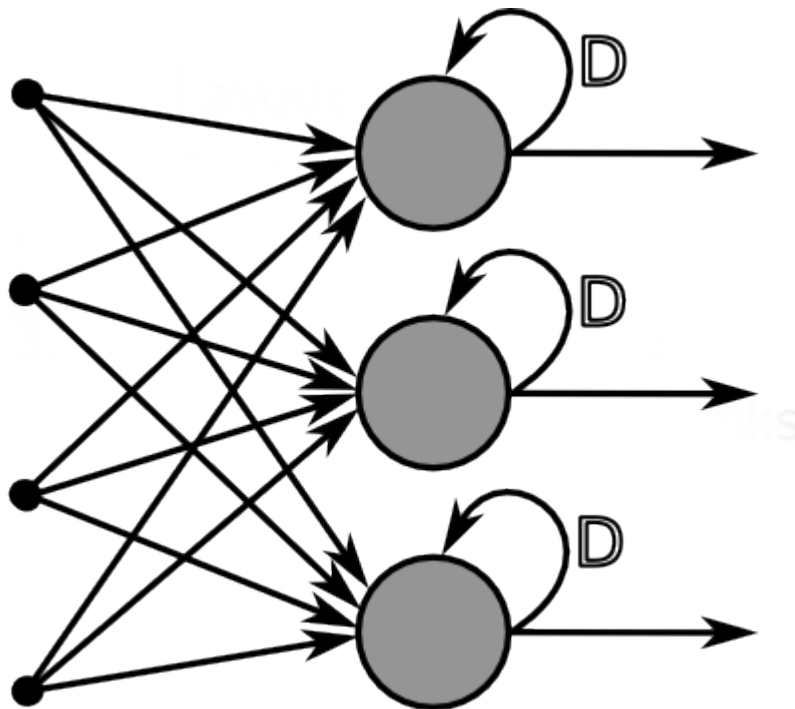


Picture 2. based on [1]<http://hubpages.com/technology/Artificial-Neural-Network>

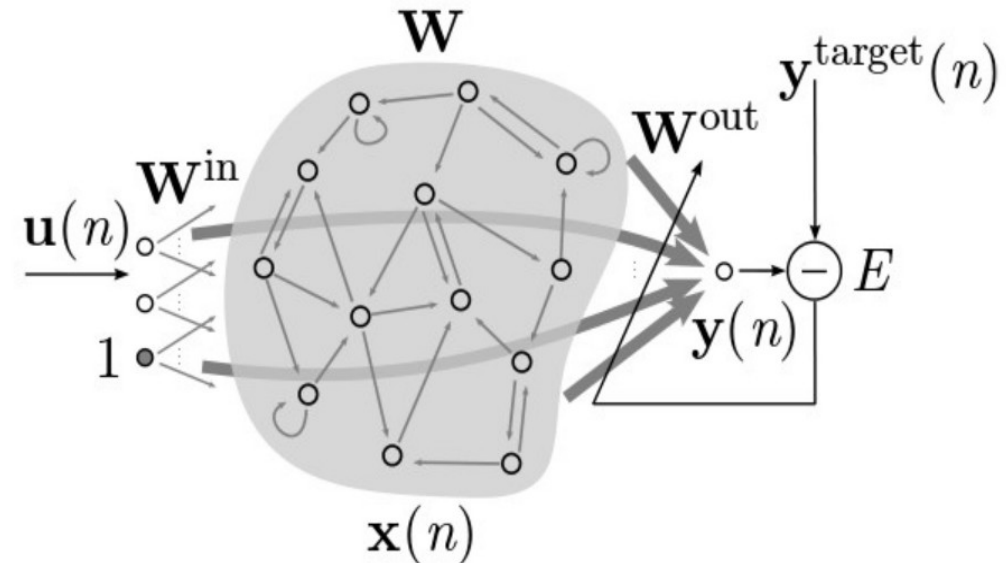
Picture 3. based on [2] <http://www.codeproject.com/Articles/175777/Financial-predictor-via-neural-network>

Architecture

Recurrent Neural Network[3]



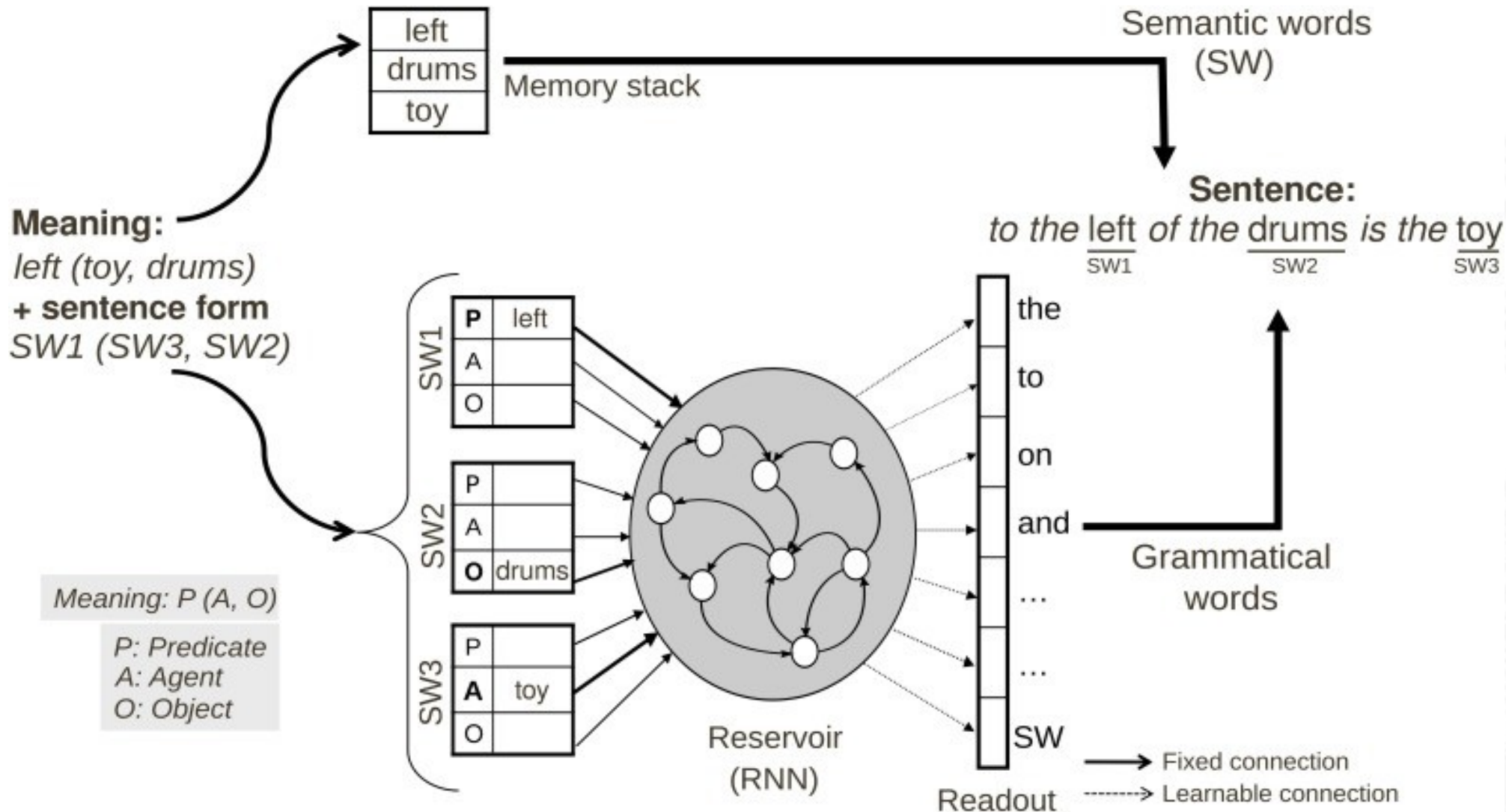
Echo State Network[4]



Picture 4. based on [3] https://en.wikibooks.org/wiki/Artificial_Neural_Networks/Recurrent_Networks

Picture 5. based on [4] H. Jaeger (2007): Echo State Networks. Scholarpedia, 2(9):2330,2007.

Neural Production Model for Scene Description Task



Picture 6. based on <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4018555/>

Stochastic Learning Grammar (SLG)

Production Rules :

```

<sentence> ::= <object> <relation> <object>    p1
            | <relation> <object> <object>      p2
            | <object> <object> <relation>      p3
<object> ::= anObject
<relation> ::= aSpatialRelation
  
```

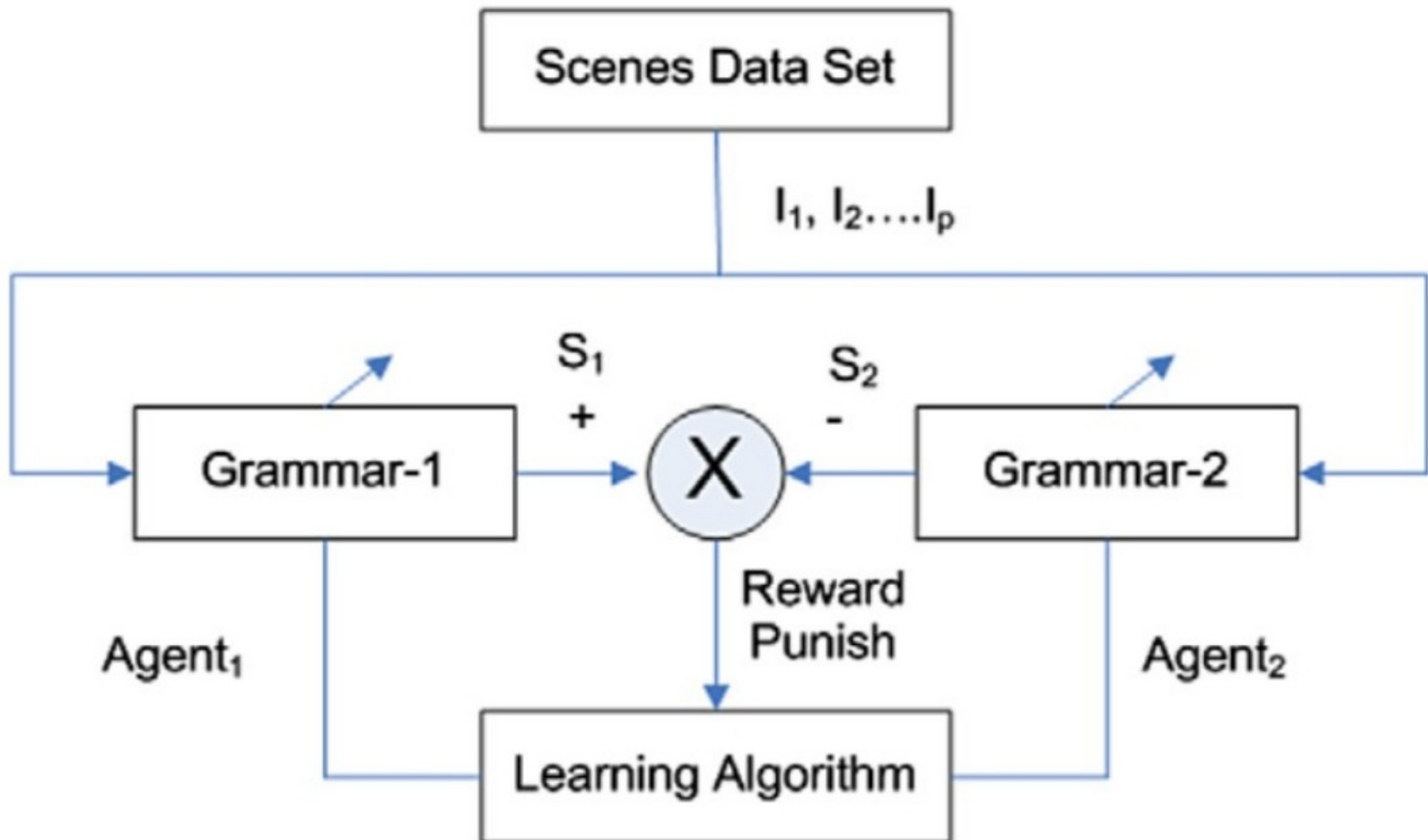
Syntactical Coordination Procedure

```

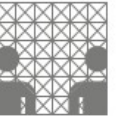
for k=1,2, .... Max rounds do
    Execute all the possible communication acts
    Compute the Communicative Efficiency of the robot team CE(k)
    If CE(k) = 100% in three consecutive rounds then
        Break
    end if
end for
  
```

Picture 7. Based on [MAR15]

Dialogic Syntactic Language Game

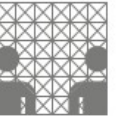


Picture 8. Based on [MAR15]



Conclusion

- Natural Language Processing addresses computers to be like human in the future.
- Neural Network approaches are key concepts of Language Acquisition between Human-Robot Interaction
- SLG and ESN has a possibility to be integrated.



Literature

[HAY94] Haykin, Simon, 1994, "Neural Networks: A Comprehensive Foundation". Macmillan

Publishing Company: New York.

[HIN14] Hinaut, X., Petit, M., Pointeau, G., & Dominey, P. F. (2014). Exploring the acquisition and production of grammatical constructions through human-robot interaction with echo state networks. *Frontiers in neurorobotics*, 8. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4018555/>

[MAR15] Darío Maravall, Jack Mario Mingo, Javier De Lope, Alignment in vision-based syntactic language games for teams of robots using stochastic regular grammars and reinforcement learning: The fully autonomous case and the human supervised case, *Robotics and Autonomous Systems*, Volume 63, Part 2, January 2015, Pages 180-186, ISSN 0921-8890, <http://dx.doi.org/10.1016/j.robot.2014.09.013>.

[LUK12] M. Lukoševičius (2012): A Practical Guide to Applying Echo State Networks. In: G. Montavon, G. B. Orr, and K.-R. Müller (eds.) *Neural Networks: Tricks of the Trade*, 2nd ed. Springer LNCS 7700, pp 659-686

[JAE07] H. Jaeger (2007): Echo State Networks. *Scholarpedia*, 2(9):2330, 2007.